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# Perception of Fishermen on Heavy Metal Pollution of the Fosu Lagoon in Cape Coast, Ghana

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**Abstract**

Many lagoons around the globe including those in Ghana are perceived to have been polluted in one way or another. The Fosu lagoon located in Cape Coast in the Central region of Ghana is among the much known ones. The importance of the Fosu lagoon includes tourist attraction, religious and economic value, of particular importance to fishermen who fish various aquatic animals, is blackchin tilapia, referred to locally as *mpatoa* with zoological name saratherodon melanotheron specie of the chiclid family. However the lagoon appears to be polluted in several ways and this is contributing to the drying of the lagoon and subsequently reducing its economic value. This study however looks at the perception of fishermen who fish in the lagoon for their livelihood to find out as to whether the lagoon is polluted with heavy metals. Sixty fishermen were sampled among an estimated 131 using the purposive and snowball sampling technique. Both open- and closed-ended questions in a questionnaire were employed to collect the data. Descriptive method of analysis was utilized in analyzing the data using SPSS software. The study identified ignorance, illiteracy, economic, and cultural factors as the reasons for fishermen's perception. This calls for the need to educate fishermen on translocation of heavy metals through plants to fishes in the lagoon. The author recommends that radio, vernacular, health and medical practitioners be used as the media of communication to educate fishermen on pollution of the lagoon and its effects.
**Keywords**: perception, pollution, heavy metals, leachates.

## 1. Introduction

Ecosystems the world over are of great importance to man. These include agricultural, recreation and sports, occupational, salt mining medicinal, genetic research and fishing among others (Cunningham & Saigo 1997, Mohammed, 1993). However many of these ecosystems are threatened by environmental problems as a result of uncontrollable anthropogenic activities. Ecosystems such as water bodies suffer similar fate. Lagoons including those in Ghana are among these threatened water bodies. Urbanization, industrialization and modernization continue to unleash their negative effects on these water bodies including the Fosu lagoon in Cape coast (Kendie 1997; Mohammed, 1993).

The Fosu lagoon is surrounded by suburbs such as Pedu, Bakaano, Siwdo, Ola and Adisadel. The lagoon has a length of about 5.17 kilometers and on latitude $5^{o}6'28.08''$ and longitude $-1^{o}51'40.32''$. One of the prominent activities that occur in and around the lagoon is fishing (Geoview, 2014).

Fish caught from the Fosu lagoon, particularly *mpatoa,* as referred to locally with zoological name saratherodon melanotheron of the chiclid family is of paramount delicacy to many people in Cape Coast (Blay, Jnr. & Asabere-Ameyaw, 2007). However the state of the lagoon has changed. The lagoon does not look attractive anymore. Fishing activities are dwindling. Economic activities among fishermen and fishmongers have reduced to the disadvantage of those who depend on these activities for their survival (Mohammed, 1993). According to Mohammed (1993), a large portion of the lagoon is covered with weeds. The depth of the lagoon has also reduced as a result of siltation. The surface area has rapidly reduced within the last thirty years or so. Many buildings have sprung up in some portions of the catchment area of the lagoon, growing at an alarming rate. Pollution and current economic activities from and around the sphere of influence of the lagoon have contributed to the current state of the lagoon (Agyapong, 2008).

The gradual extinction of the lagoon could be attributed to unsustainable settlement planning in many geographical sites surrounding the lagoon. Among these is the campus of St. Augustine's College, a second cycle institution. Effluent and sewage discharge directly from its laboratories into the lagoon. Similar discharges from the Cape Coast Metropolitan Hospital find their way into the lagoon. Domestic solid and liquid wastes from Bakaano Township are also discharged into the lagoon (Mohammed, 1993).

Leachates from a dumping site at Adisadel estates, close to the Adisadel village, the Ankaful and Nkanfoa waste disposal sites also find their way into the lagoon. Runoffs and leachates from the Siwdo automobile garages and workshops, with oils, paints and other solid wastes flow directly into the lagoon. Metal scraps, garbage and night soil all find their way into the lagoon (Ahuahey, 2007; Essumang, Dodoo & Kendie 2006; Adjei, 1998).

 

Pollution of the lagoon has for these reasons become of great concern particularly with reference to the fact that fishermen continue to fish from the lagoon. It is on record that sediments, water and fish from the lagoon are infected with various kinds of pollutants of which heavy metals are included (Arthur & Eshun, 2012; Eshun, 2011; Akwansah-Gilbert, 2007; Dadson 1996; Adjei, 1991; Tay 1998; Hagan 1986;). These metals can be translocated through plants into people who consume fish caught from the lagoon. Through physical contact with lagoon water, fishermen could also suffer from dermal medical conditions.

A recent report by Obodai, Okyere, Boamponsem, Mireku, Aheto & Senu (2011) indicates that concentrations of heavy metals such as lead and cadmium are high in the blackchin tilapia in the Fosu lagoon. Lead and cadmium could be harmful to humans in relatively small amount but in accumulated form in the human body. However fishermen may neither have idea on the fact that the lagoon is generally polluted, nor be in the known that the lagoon water is polluted with heavy metals. They may also not know that fish in the lagoon are polluted with heavy metals. Investigating into these issues will help stakeholders adopt the best educational tools and techniques to better inform fishermen of the conditions of the water, sediments and fishes in the lagoon in relation to their fishing activities.

*1.1 Aim*

The aim of the study was to find out the perception of fishermen on heavy metal pollution of the Fosu lagoon in Cape Coast, Ghana.

*1.2 Objectives*

The specific objectives of the study were to:

- determine source of heavy metal pollution of lagoon from the point of view of fishermen;
- find out the perception of fishermen on heavy metal pollution of the lagoon; and
- determine the perception of fishermen on heavy metal pollution of fish in the lagoon

**2. Pollution**

Generally there are three types of pollution. These are air, water and soil pollution. Air pollution may be defined as the release of physical chemical, biological material or wave form into air space at such magnitude that its harmful effect can affect the healthy or comfortable existence of living organism or the quality of non-living matter now or the future. Soil pollution, on the other hand, is the decrease in soil productivity, deterioration in quality of plants and ultimately ground water by the addition or removal of substances from the soil. Water pollution is the addition of any substance to water which may change its physical, chemical or biological characteristics in any way such that it's useful legitimate purpose is affected (Sinha, Sukla & Sukla, 2005).

Polluted water is non-potable but rather may be turbid, bad smelling, unfit for drinking, washing and/or other useful purpose. Polluted water may also affect aquatic plants and animals. Polluted water bodies therefore have direct relationship to health and welfare of humankind. Pollutants that may pollute these water bodies include heavy metals. Heavy metals such as lead and cadmium that enter rivers, lakes and lagoons can cause serious health hazards to living organisms (Sinha et al, 2005).

*2.1 Heavy metals*

According to Cunningham & Saigo (1997) toxic effluents, water pollutants and mounts of solid hazardous waste are becoming devastating problems in both developing and advanced nations. Millions of tons of dangerous materials including heavy metals are produced daily and disposed of in unsafe and irresponsible manner. Heavy metals are metals that can be noxious at relatively low concentrations. They are non-degradable, non destructible and can be toxic to man, animals and plants through some regulated biochemical associations that take place in living organisms such as protein controlling biochemical reactions (Akwansah-Gilbert, 2007). They have relative densities 5 or higher. They can cause many dangerous non-communicable and non-infections diseases. When they enter the body their effect could manifest either immediately or take a relatively longer period of time depending on the quantity that enters the body through the food chain or otherwise (Hart, 2008).

Some heavy metals in wee amounts are essential for the maintenance of food metabolism in the human body. Some of these elements are zinc, iron, magnesium and copper. They are the essential trace elements or micronutrients which are useful to human life since their deficiencies may cause serious biological dysfunction. Excess intake, however may be toxic to human life. (Akwansah-Gilbert, 2007)

Some heavy metals however may be toxic in small quantities in the human body. Their toxicity is manifested in their context for sites with essential metabolites causing damage to healthy cell membrane (Anukwah, 2007). They include mercury (Hg) arsenic (As), titanium (Ti), lead (Pb) and cadmium (Cd). Several negative medical conditions in the form of diseases are caused by these elements. Examples include cancer, mental retardation among children and painful bones (Bellinger, 2008; Kido, Nogawa, Horida, Tauritani, Ishizaki & Yamada, 1990).

There can be transportation of quantities of heavy metals (non-essential) to leaves and then to fruits and seeds of plants, including aquatic plants when they are close to or in water bodies. These may eventually find their way

 

into water bodies, whether the water body is a habitat for the plant or act as waste disposal sink to these organic plants. As a result certain animals including fishes in these habitats accumulate heavy metals in their tissues and other organs when they feed on the plants (Anukwah, 2007). Being the medium through which these fishes reach consumers it is important to investigate how fishermen perceive pollution of heavy metals in these water bodies such as lagoons and particularly, the Fosu lagoon in Cape Coast. This is because fishes in the lagoon, particularly the blackchin tilapia are highly patronized by the inhabitants of the metropolis and beyond.

*2.2 Heavy metal pollution of the Fosu lagoon*

Manifold of research works carried out over the years show that the Fosu lagoon is polluted. The pollutants include heavy metals among others. Heavy metals in the lagoon include copper, mercury, lead and cadmium. Copper concentrations ranged from 90-102 ppm (Hagan, 1986). Concentrations of copper in lagoon algae ranged between 0.19 and 1.04ppm. Dry weight concentrations in lagoon sediments were between 48.3 and 106.85ppm (Adjei, 1991). Mercury pollution in lagoon water stood at 0.008ppm (Hagan, 1986) while average concentration of mercury in algae surged to between 0.397 and 1.0309 (Tay, 1989). The Average lead concentrations were found to be between 48.3 and 106.85ppm (Adjei, 1991). Cadmium concentration in sediments was 0.78-33mg/kg, higher than the 0.7mg/kg being the Canadian Interim Cadmium Marine/Estuarine Sediments Guideline for the protection of aquatic lives (Akwansah—Gilbert, 2007). Lead concentration in lagoon water was found to be 0.2904-0.3096ppm (Ahuahey, 2007). Obodai et al (2011) recorded higher concentrations of lead and cadmium in blackchin tilapia muscle in the Fosu lagoon. Lead- and cadmium-contaminated tilapia when consumed could have long term health effects.

## 3. Research methodology

Out of an estimated average of 131 fishermen, 62 were targeted with a response rate of 96.7% making up 60 of the fishermen. The snowball and purposive sampling techniques were used with open- and close-ended questions in a questionnaire. An unstructured interview was utilized on few instances for further clarification. The questions looked at issues concerning fishermen's perception as to whether indeed the Fosu lagoon is polluted. Further the questions looked at specific cause(s) of the pollution as to whether the pollution is due to heavy metal disposal over time. This perception was further considered in gender respects. Finally, age group considerations were analyzed to ascertain whether the perception obtained went for all age groups. The SPSS software programme was used in the analysis of the data. The descriptive analysis tool was employed using frequencies and graphs; and median and mode when necessary, to analyze the data.

## 4. Results and discussion

The socio demographic parameters of fishermen considered in the study include gender, age, highest educational attainment, monthly income and years of fishing. All respondents to the questionnaire were males indicating that fishing in the lagoon is a predominantly male preserve. Mean and modal ages were found to be 43 and 41.9 years respectively with a range of between 30 and 59 years. Majority of respondents (70 percent) had primary, middle or junior high school as their highest educational attainment with 30 percent being illiterates. Eighty percent of respondents received a mean daily wage of $ 2.25 per day which is above the international poverty threshold of $1.25 per day (Ravallion, Shaohua & Sangraula, 2009) and a daily modal wage of $1.6per day. Years of fishing ranged from 15 to 66 years. The mean and modal years of fishing were 31.7 and 27.5 respectively. Fifty percent had fished in the lagoon for a period between 20 and 29 years; 83 percent between 20 and 39 years.

Figure 1 shows the perception of fishermen on size reduction of the Fosu lagoon. Majority (55 percent) of the respondents were of the opinion that the lagoon had reduced in size. One major reason which suggested that the lagoon had reduced in size, according to their observations, was the difference in catch for the last ten years.

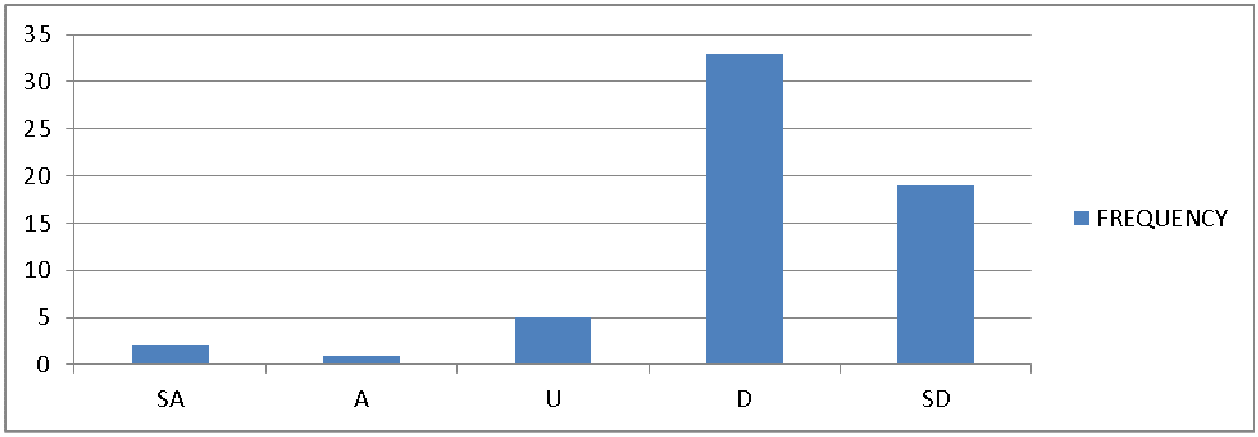


Figure 1: Perception on lagoon size reduction* (Source: Field data, 2012)

*(SA is strongly agree; A is agree; U is undetermined; D is disagree; SD is strongly disagree)

 

They indicated that catch per fishermen had reduced from about 21.6kg to 16.4kg per week, a decrease of 24.1 percent for the last 10 years or 50; an annual reduction rate of 2.4 percent per annum. The mean weight of fish caught per week between 2001 and 2011 as observed by the fishermen and the percentage changes are shown in table 1. Annual mean reduction rate was found to be 6.7 percent.

Table 1: Catch of fish per week per fishermen (Source: Field data, 2012)

| Weight (kg) | 2001[frequency(%)] | 2011[frequency (%)] | Change (%) |
|---|---|---|---|
| 8 | 0(0) | 4(6.7) | +6.7 |
| 12 | 14(23.3) | 12(20) | -3.3 |
| 16 | 24(40) | 4(6.7) | -33.3 |
| 20 | 12(20) | 16(26.7) | +6.7 |
| 24 | 12(20) | 4(6.7) | -13.3 |
| 28 | 12(20) | 0(0) | -20.0 |
| 36 | 6 (10) | 0(0) | -10.00 |
| Total | 60(100) | 60(100) | -66.5 |

The respondents were of the view that the reduction in catch could be as a result of increase in the number of fishermen in the lagoon and the absence of trees, including coconut trees around the catchment area. As indicated by Mensah (1997), this could in turn be due to heavy metal pollution of the lagoon environment. For the remaining 45 percent, 30 percent could not decide on the state of the lagoon (refer figure 2). The remaining 15 percent disagreed that the lagoon had reduced in size. Illiteracy and ignorance could be the reason for indecision when the highest educational attainment of the respondents is taken into consideration.

Figure 2 depicts the responses as to whether the respondents did agree that the Fosu lagoon was polluted with heavy metals. Majority (86.7 percent) responded in the negative only 13.3 percent agreed that the lagoon was polluted while the remaining was undecided. However 73.3 percent of the respondents were of the view that the Siwdo workshops and garages could be a major source of contamination to the lagoon. This is in agreement with the findings of Abekah (1993) and Mensah (1997) that the workshops and garages were a contributing factor to lagoon pollution. About 10 percent also indicated that the lagoon pollution was due to garbage and refuse from the Bakaano Township, St. Augustine's College, Adisadel Estate residential area and the Ola Hospital (Akwansah-Gibert, 2007; Mensah, 1997; Kendie 1999; Abaka, 1993; Habib, 1993, Biney 1982). Leachates from Nkanfoa waste disposal site and the landfill site (waste) at Adisadel could also contribute to pollution of the lagoon (Essumang, Dodoo & Kendie 2006).

Majority (70 percent) of the respondents were of the view that though feacal matter, organic matter, Polythene garbage and other refuse from the Siwdo workshops and garages, Adisadel and other parts of the metropolis got into the lagoon, they did not pollute it. This explanation may be an attempt to protect their occupation since none of them earned less than $1.25 per day from their fishing activities and that they depend on fishing for their livelihood. This is the international poverty threshold (Ravallion, Chen & Sangraula, 2009). Illiteracy may also be a factor since the highest educational attainment among fishermen was basic school education (70 percent). The sources of pollution, as observed by the fishermen, however, were in agreement with various research findings by Akwansah-Gibert (2007); Mensah (1997); Kendie (1999); Abekah (1993); and Biney (1982). It is for these reasons that as preventive measure Ahuahey (2007) suggested that a good management policy should be drafted and implemented for the workshops and garage operators at Siwdo. It is for a similar reason that Agyapong (2008) also thought that desilting the lagoon will clear the waste that have accumulated in the lagoon over the years.

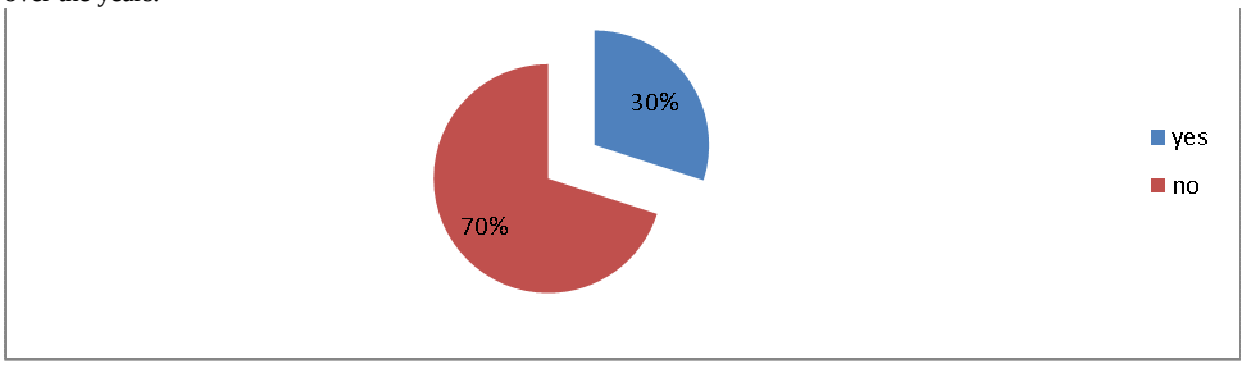


Figure 2: Perception on heavy metal pollution of lagoon ( (Source: Field data, 2012)

 

Fig 3 shows the responses of the fishermen with regards to heavy metal pollution of tilapia. Thirty-six respondents (60 percent), which constituted the majority either disagreed or strongly disagreed that there were toxic heavy metals in the lagoon though 46.7 percent of them confirmed that they had on one occasion or the other seen scrap metals in the lagoon. The reasons given by some of the respondents (46.7percent) to support this contention were that, all scrap metals generated from the Siwdo workshops and garage were currently sold for recycling. They were however quick to explain that metals used to be found in the lagoon but for the scrap-metal collection business whereby scrap metals are collected and sold to scrap dealers for the purpose of recycling. They also indicated that no doctor had told nor proved to them that fish in the lagoon contain toxic metals. Some of the respondents claimed to be involved in old and new scrap metal collection and dealership for recycling purposes for which reason they were of the view that both lagoon water and fish in the lagoon could not be polluted with heavy metals even if such condition existed.

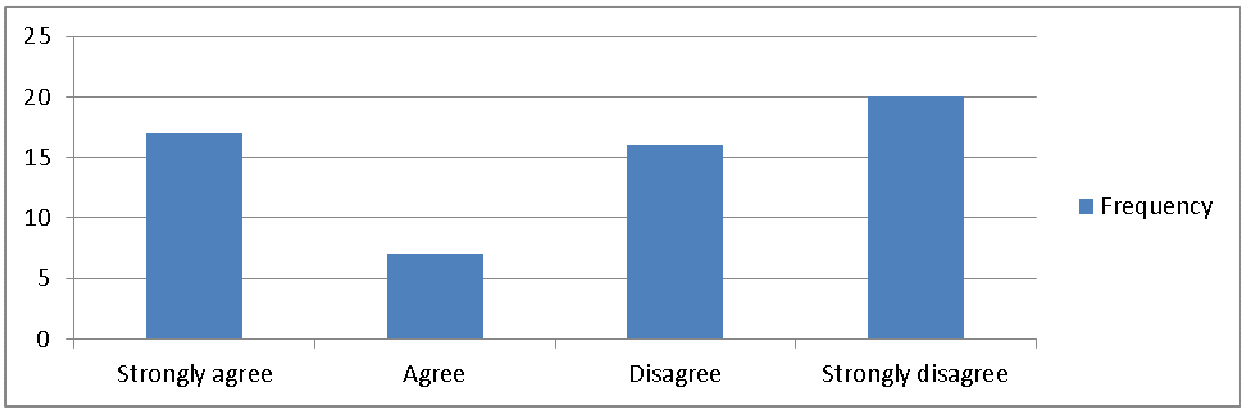


Figure 3: Perception on heavy metal pollution of lagoon fish (Source: Field data, 2012)

A few of the respondents (3.3 percent) said “fishes don’t eat metals” as one of the reason not to agree to the assertion. The remaining ten percent of the respondents could not explain why they disagreed that there were lead and cadmium concentrated in fish in the lagoon. On the other hand forty percent of the respondents agreed that there were heavy metals in fishes in the lagoon (refer figure 3). However majority (66.7percent) of these respondents stated that they had on one occasion or the other found pieces of metals in the lagoon. Chemical dissolution and consequent leaching as well as surface runoff are processes through which heavy metals get into the lagoon. The translocation of heavy metals is through chemical processes. The respondents therefore showed ignorance to the food chain concept. This could be attributed to low educational background since their response appeared to imply that fishes could ‘eat’ physical metals directly.

Out of the 60 respondents 24 (40%) agreed that lagoon fish was polluted of heavy metals. The analysis of respondents’ age in relation to perception on heavy metal pollution of lagoon fish indicated that 100% (1 respondent) of those between the age groups 60-69 and 70-79 agreed that the lagoon could be polluted with heavy metals due to the closeness of the Siwdo workshops and garages to the lagoon; a little over 33% (8 respondents) in the 50-59 age group, 33% (9 respondents) of those in the 40-49 age group and 20.8% (5 respondents) of those in the 30-39 age group shared the same opinion; none was in the 20-29 year group (refer figure 4). Thus it appeared perception on lagoon pollution increased from the 20-29 year group to the 70-79 year group. The perception on a natural habitat is based on observation, experience, and time coupled with cultural inferences among others; hence age could be one of the cardinal factors that could affect fishermen’s views on the state of the lagoon.

 

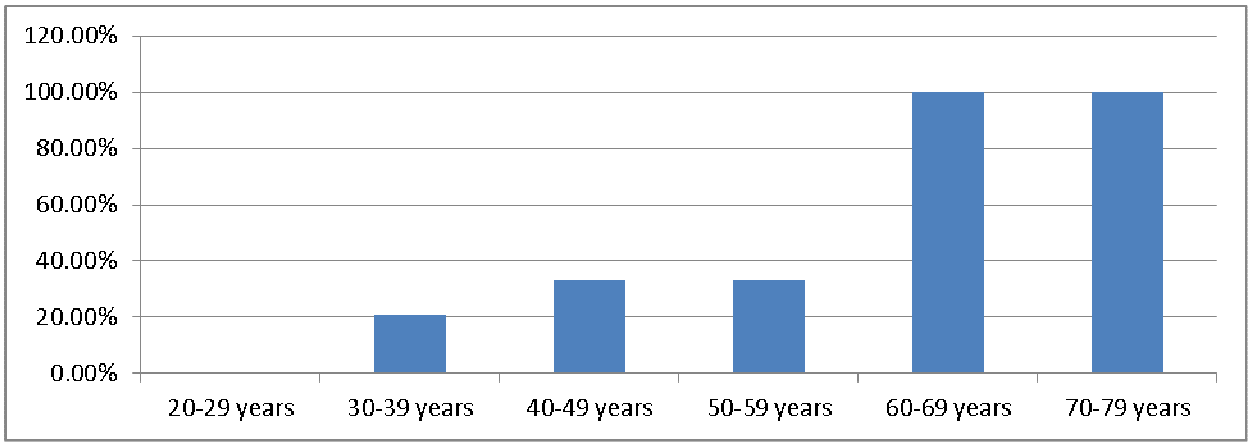


Figure 4: Distribution of age group perceptions on heavy metal pollution (Source: field data, 2012)

According to the study, though the activities of scrap metal dealers had increased of late, some tailings and scraps still found their way into the lagoon. Most metal scrap dealers rather dealt in few non-ferrous metals such as aluminium and ferrous metals. But sources of heavy metal include motor vehicle body paints, plastics, lubricants and fuels among others and not metallic waste only. The increased activities of scrap metal dealers in Cape Coast may therefore not be enough indication that heavy metals might not find their way into the lagoon and fishes, and consequently ingested into people who consume them.

In the opinion of the researcher the physical presence of metals in the lagoon is an indication that there is both physical and chemical pollution of the lagoon. This is because favorable conditions in the lagoon such as the presence of some chemicals might dissolve physical metals and make them accessible to other aquatic botanical and zoological biota and finally, fishes in the lagoon.

The observation of majority of the respondents (73.3percent) was therefore in agreement that various activities that take place at the Siwdo workshops and garages could be major sources of heavy metal pollution into the lagoon (Arthur & Eshun, 2012; Eshun, 2011) and subsequently into humans through the food chain. Leachates from Nkanfoa and Adisadel refuse dumps are also major sources of pollution into the lagoon (Essumang, Dodoo & Kendie, 2006).

## 5. Conclusion and recommendations

The result of the study has shown that majority of fishermen perceive that the lagoon was not polluted though majority were of the view that the lagoon had reduced in size for the last thirty years or so. In terms of heavy metals pollution most fishermen were of the view the lagoon was not polluted and that contamination of the lagoon was caused by refuse, industrial waste and garbage, mainly from the Siwdo workshop and garages, Bakaano Township, Adisadel estates St. Augustine College Metropolitan hospital at Ola as well as the minor sources. Majority of fishermen did not perceive that there were heavy metals in water and fishes in the lagoon and that these toxins could be translocated to humans through the food chain from water and plants to humans. Perception on heavy metal pollution appeared to increase with age. Fishermen had no idea on the leaching process; that heavy metals could leach from Nkanfoa, Esuekyir and Adisadel waste disposal sites into the Fosu lagoon. They see fishing as something inherited and as a way of life. Some were of the view that even if lagoon was polluted it would be difficult for them to stop their fishing activities since their living depends on it. Illiteracy, economic incentive and cultural factors appear to be the influencing parameters for fishermen's perception.

Based on the concluding part of the study it is recommended that using newspapers (written in English) to educate fishermen on leaching and poisoning through the food chain will not go down well with the fishermen. Fishermen's confidence in medical officers, particularly doctors was also communicated during the study. It is therefore recommended that radio and television be used in educating fishermen on pollution of the lagoon. Medical officers using vernacular (local language) in this regard could go a long way to achieve the purpose of the education process. The processes and effects of leaching, pollution and the food chain should be explained by educators to the core in this context.

 

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